1921

Cost system for an electric cable plant

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NATIONAL ASSOCIATION
of
COST ACCOUNTANTS

Official Publications

Vol. II AUGUST 15, 1921 No. 19

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AUGUST 15, 1921

A COST SYSTEM FOR AN ELECTRIC CABLE PLANT

The chief problem in building up a cost system is not so much to set up numerous accounts and employ various devices in keeping records, as to insure that every entry, account and report included in the system has a definite purpose and that it carries out that purpose. An accounting record is of value only when the information it discloses is used.

The wise fruit grower would not keep in his orchard a tree that did not bear, but would cut it down. His work, however, is not finished when he has destroyed non-bearing trees and has harvested his crop, because he still has to sell his product. So it is with a cost system. The purpose of a cost system is only carried out when it has been sold and kept sold. Then it becomes a necessity. Unfortunately, however, full use is not always made of a cost system. Those reports and statistics which are not eagerly awaited by someone outside of the accounting department will remain buried in the files. It is important, therefore, that the accountant be analytical and that he eliminate all work which yields unused information.

Description of Product

Before describing a cost system applicable to the manufacture of electric cables, it might be of interest to describe briefly the nature of the product.

Electric cables may be divided into two general classes, those used for the transmission of electrical power, and those used in telephone and telegraph transmission work. The methods of manufacturing these two classes differ materially. In order to avoid unnecessary detail, only the first class of cable, which is of the greater interest, will be described.

Power cables in turn are of two kinds, namely, bare and insulated. The former always has a single conductor, while the latter may have one, two, three or even four conductors. A conductor is a rope made up of small copper wires twisted together. In large conductors there may be more than one hundred and fifty of these wires or strands. Bare cables are used for aerial transmission, while the insulated type is used for underground and

submarine installations; and also for the interior of buildings. Bare cables, as the name implies, are not insulated. Insulation is usually paper, fabric, or rubber, which is wrapped or formed around the conductor. The paper insulated cable passes through more operations usually than any other cable. If the cable consists of more than one conductor, the conductors are laid side by side and bound together. Then the cable is thoroughly dried, regardless of whether it is of single or multiple construction. The next step is to saturate it with an insulating compound which fills every interstice. The final step is to force a tight fitting sheath of lead around the cable by means of a hydraulic press.

The purposes of the various parts of such a cable are as follows. The conductors are composed of a number of strands in order to make them flexible. Cables are made up of two or more conductors in order to make them more economical and practical, that is, so one cable may be used for handling any two-wire circuit or two-phase or three-phase circuit, as the case may be.

For the transmission of high voltage electrical power over long distances, the aerial bare cable is used. For underground and all other uses, cables must be insulated to prevent one conductor from touching another. Paper insulated cables are largely used for transmission of electricity at high voltages. For this use it is necessary that all moisture be removed, because if there is any moisture or air space in the insulation, loss of energy and possible burning out of the cable will result. The lead sheath serves to protect the insulated conductors against moisture as well as the chemical action of acids and other foreign substances that are present, in greater or less degree, in conduits, in the earth, etc. Moreover, it serves to protect the cable from mechanical injury, either during installation or thereafter. In addition to the lead covering, submarine cables have an armor of galvanized steel wire and insulating material to further protect the cable from any physical or chemical damage that might be sustained from various outside sources.

Cost of Sales

The cost system described in this article, like many others, has three chief purposes: to arrive at the monthly cost of sales, to compile statistics for use in predetermining costs, and to furnish a basis for production control. Each one of these purposes will be discussed in turn.

The product of a cable mill is usually of such a nature that it is inadvisable to manufacture for stock, because all purchase orders are received accompanied by definite specifications. Accounts are opened for all orders received in the "cable mill work in process ledger." The ledger sheets provide the following information: name and number of order; full description of order

as called for by the specification; date and quantity shipped; metal prices applying to the order; summary of cost and sales values and the profit or loss in total and per foot or per pound; rolling and drawing charges; materials, fourteen kinds, each being kept in a separate account;[1] labor operations, fourteen different operations;[2] burden—shop, general and fixed charges and administration and selling expenses—each applied on its own basis; and abnormal charges incurred on an order.

The ledger sheet is arranged in sets of columns, each set consisting of two columns, one for the weights of material, man-hours or machine hours, and the other for the values of material, man-hours or machine-hours. To each set of columns are posted the results of the month's operations as shown by tabulated reports explained later in this article. Several of the above items shown on ledger sheets will be explained in detail.

METALS

Metals used in the manufacture of cables are chiefly copper and lead. When it is considered that metal prices fluctuate rather widely at times and that 45 to 88 per cent of the total cost of an order for cable is the metal value in the cable, it is evident that buying is an important feature and must therefore be intelligently conducted; and that the best method of handling the metal cost so that final comparison of costs and revenue will be on a comparable basis, should be selected.

The system being discussed is based on the assumption that a cable manufacturing company is in business for the purpose of making a profit from its manufacturing operations and not from buying or selling metal. If it makes a profit or loss on metal, this amount should not be considered as a part of the manufacturing profit or loss.

When an order is received (or taking all the orders received for the day), the company will try to purchase the metal required. Inasmuch as this purchase is made practically at the same time that the selling price is set, the purchase price of the metal in most instances will be the same as the price for metal used in setting the selling price, the latter being the market price on the date the quotation was made. In order to handle the metal transaction on the books in such a case, the proper metal accounts are charged with metal receipts at the value per pound used in setting the selling price of the orders for which the metal has been purchased. Any difference between this amount and the actual

[1]The fourteen kinds are: 45-pound paper, 90-pound paper, paper filler, 120-pound jute, 240-pound jute, rosin, London oil, isoline, petrolatum, miscellaneous, copper wire, lead, tin, and antimony.

[2]The fourteen operations are: Cutting paper, winding wire, stranding, stranding high speed, conductor insulating, jacketing, cabling, drying, impregnating, leading, testing, shipping, armoring, and miscellaneous.

amount paid for the metal is charged or credited, as the case may be, to a metal pool account which thereby shows at the end of a given period the profit or loss made on metal transactions. For the sake of illustration, consider that orders have been received which require 50,000 pounds of copper in their manufacture. Assume that the copper price in the quotation is 15 cents, but that the 50,000 pounds purchased for this order are bought, however, for 14¾ cents per pound. The journal entries for this transaction are:

Dr. Copper	50,000 lbs.	$7,500		
Cr. Vendor				
Metal Pool Profit and Loss.....				125
Dr. Cable Mill Copper in Process....	50,000 lbs.			
Cr. Copper Account.....			50,000 lbs.	

At the time of shipment the following entry would be made:

Dr. Cost of Sales.....	50,000 lbs.	$7,500		
Cr. Cable Mill Copper in Process.			50,000 lbs.	
Copper Account				$7,500

Thus the metal value is not recorded in the various work-in-process accounts, the latter accounts being charged and credited with weights only. By this procedure, if a shipment is made in June on an order received in January, and the price of copper has dropped from 18 cents to 13 cents, the order will be charged at the metal price it was taken at, thereby giving a cost of the order, which is comparable with the sales value.

Monthly departmental inventories of unfilled orders are received from the order department, and the metal weight and value on these orders are checked with the book weights and the value of the metal on hand. Any difference between these two figures represents either more metal on hand than is needed for orders; or if metal requirements are greater than the metal on hand, then of course the difference represents necessary material that must be purchased to fill these production orders.

The question of metal scrap presents no great difficulty because the percentage of scrap is very small, approximately 1½%. The actual melting loss on copper is also very small. The cost of handling and redeeming this copper scrap is charged as a shop burden item. Since lead scrap is used again in lead pots at the lead presses, no redeeming charge is incurred.

Rolling and Drawing Charges

The rolling and drawing of copper to the gauge required by the cable mill is done in the rolling and drawing departments, and not in the cable mill. The rolling and drawing is known as "pre-department" cost.[1] The wire, however, is not charged to the

[1]This pre-department cost includes all costs of the product, except metal, up to the time it reaches the cable mill.

cable mill at cost, but at the same sales price quoted on quantity orders to customers who buy wire. The sales price of the wire to the cable mill is charged to factory orders when used. It should be noted that this cost does not include any metal cost, but only the sales value of rolling and drawing wire. Each order is charged with the rolling and drawing charges of the wire actually contained in the shipped cable as well as any rolling and drawing charges, of that portion of the wire which is scrapped.

The difference between the actual pre-department cost (rolling and drawing cost) and the sales price charged to the cable mill is set up in an interdepartment profit and loss account. A reserve is maintained to cover this difference in price on that portion of the wire remaining in inventory in the cable mill at the end of each period.

Material Costs Other than Metal

The other materials listed under item seven are charged to factory orders when issued from stores or sub-stores. These materials, with the exception of saturating material and lead, are weighed. In the case of saturating material and lead the cable is weighed before it is placed in the saturating tank, and again after it is removed from the tank, and also after it has been leaded. Lead is charged to orders on theoretical figures based on cross sectional area of the lead sheath. At the end of each month an actual inventory is taken of the lead and saturating material in the cable mill by weighing, and by means of charts for the tanks and pots. On the charts used for this purpose, curves are drawn which provide means for computing the weight of compound in an impregnating tank when the kind of the compound and its depth in the tank are known. A layer of compound one inch deep will have a certain weight. Multiplying this weight by the number of inches of depth will give the total weight of compound in the tank. The charts are arranged to show along one side, a scale of depth of the tank in inches, and along the other side a scale of weights. Lead in pots is handled in a similar manner. Any slight variation between the amount consumed as shown by the charges from stores for the month plus or minus the difference in inventory at the beginning and and of the month and the amount charged to orders, is adjusted to all orders saturated and leaded during the month. Some of the material requires preparation before it can be used directly on orders. The labor for this preparation, with its respective burden and the material necessary, are charged to sub-stores.

The material requisitions as well as the "operating reports"[1]

[1]These reports, which are prepared each day, contain all the data that should be kept in regard to machines. They show the order numbers, man numbers (time clock numbers), man-hours, machine hours, and machine delays.

are made up in the mill and, after being priced, extended and checked, are sent to the tabulating office. Tabulating cards are punched to show the information contained in the reports. When the last of the month's transactions has reached the tabulating office, all the cards for the month are sorted and tabulated according to the bookkeeping requirements. In the case of requisitions, two tabulations are made by the tabulating eqiupment. One shows the charges against each order number and the other the credits to the material accounts. These tabulations serve as the journal entries from which postings are made to the various accounts.

BURDEN

No attempt is made to distribute the burden charges for any one month over the work in process during that month, because it would delay the closing of the books and the issuing of statements of cost of sales for the month. The method of distributing burden is to apply an estimated set of rates. The rates selected are based largely upon the average of the actual rates of the different operations for the months immediately preceding the current month. These rates are used for the purpose of having the jobs worked on during the month absorb all of the burden charged to the cable mill during that month. It should be emphasized that while the production is charged with all of the actual expenses charged to the cable mill, the matter of predetermining costs for sales department purposes is handled in another way, as explained later. Furthermore, the cable mill as well as the other eight producing mills in the plant, all of which manufacture a different class of product, are charged with the following items of burden after adjustments for unabsorbed or over-absorbed expense based on normal operating conditions are made; power and supervision, which are part of the shop burden; and general burden, fixed charges, and administrative and selling expenses.

The line of demarcation between shop burden, general burden and fixed charges is as follows: Shop burden includes all items of expense that the superintendent of the mill controls or is responsible for. General burden includes all manufacturing expenses which are beyond the control of the mill superintendents, such as factory administration, engineering, laboratory, purchasing, stores, factory accounting and general plant repairs, etc. Fixed charges, and administrative and selling expenses include depreciation, administrative expense, selling expense, bond interest and organization expense, etc.

The establishment of what is the normal operating condition should be carefully considered by all parties concerned in the operation of each mill. In the mill under consideration, previous records warranted using as a reasonable normal operating condition, the total man hours (one shift) of the total number of men required to run the mill on a capacity basis, or 100% for one shift. Usually

about 80% of this amount is considered normal, but the plant being discussed frequently works two shifts.

If the mill is operating at half time, the supervising expense, fixed charges and general burden are charged to the mill only on the basis of actual operating conditions. In other words, the mill is charged only with the expenses it actually incurs. Any excess or deficiency is charged or credited, as the case may be, to the respective unabsorbed or over-absorbed burden accounts and from there direct to the profit and loss account.

Power expense is treated in a similar way. If the total plant expense prorated over the amount of power and steam delivered as indicated by the meters, shows that the power expense has increased per unit of power due to the idleness of the plant, that portion of the power expense chargeable to idleness is written off as unabsorbed power expense before being distributed to the cable mill work in process account. Charts are prepared to show the normal cost per unit of power expense at various coal prices. Due to the possible great fluctuation in the price of delivered coal, the cost per unit of power may vary considerably from month to month without necessarily causing a charge to be made to the unabsorbed power expense account. As an illustration, assume that the cost of coal in March is $5 per ton, and in August $10 per ton. Assume also that during these months the plant is operating at normal production. Under such circumstances no charge would be made to unabsorbed power expense in either month, but the rate per K.W.H. charged to the mill in August will be much greater than the rate charged in March.[1]

In regard to repairs, care should be taken to see that the current period is not penalized with repair charges for repairs which should really have been made and charged in some former period. The cost accountant sometimes finds when he undertakes an engagement that the machines in a plant are in a more or less run down condition and that in past years no adequate provision for depreciation has been made. If it is found that a piece of equipment requires complete overhauling due to insufficient repairs in former years, the portion of the expense chargeable to former years should be charged against a depreciation reserve and closed out at the end of the period to the profit and loss account. Each mill's repairs proper should be charged to a "mill repair

[1] Power expenses are posted from the voucher register to the power plant expense account in the factory ledger. At the end of each month the total plant expense is divided by the number of pounds of steam generated, which gives the cost per pound of steam. If the cost per pound so found exceeds the normal cost per pound as indicated on charts mentioned, (i.e., the normal cost based on the coal price charged for coal used during the month), the excess is charged to unabsorbed power expense.

Steam is used by the operating departments direct, and also to operate electric generators. The cost of steam used direct is charged on a pound basis to the departments using it, and the amount charged for that used by the electric generators is in turn charged out on a kilowatt hour basis.

and maintenance account" and in turn charged to shop burden each month on the basis of a machine hour rate obtained by taking the actual repair charges for the twelve months immediately preceding and dividing them by the corresponding machine hours. This rate is then applied against current machine hours.

Burden distribution requires keen judgment and vision. A method applicable to one plant will not necessarily be suitable to another plant. The conditions in each plant should be carefully studied in order to see that the proper methods are adopted. This point can be brought out by an illustration. In the manufacture of cables, it was found that the final amount of burden allocated to two jobs, one for bare cables, and the other for lead covered cable, as compared with the direct labor on these two orders was in the ratio 1 to 2.65, as shown by the following table:

USING PRODUCTIVE MAN-HOUR AND MACHINE-HOUR BASIS

	Order No. 1	Order No. 2
Labor	$1.	$1.
Burden	1.	2.65
Total Labor and Burden....	$2.	$3.65

USING DIRECT LABOR BASIS

	Order No. 1	Order No. 2
Labor	$1.	$1.
Burden	1.825	1.825
Total Labor and Burden....	$2.825	$2.825

For the purpose of arriving at the different burden rates the following forms, which are self-explanatory, are used. These forms are used to compile data covering a period of three months or longer. They are never used for a period of less than three months.

FORM FOR ANALYSIS OF BURDEN

.....Mill Date.....

1	2	3	4	5	6	7	8	9	12	13	14	15
Operation	Man Hrs.	%	Mch. Hrs.	%	Ind. Lbr.	Supplies	Pwr.	Rep.	Misc.	Total	Man Hrs. Rate	Mch. Hr. Rate
1												
2												
3												

FORM FOR DISTRIBUTION OF INDIRECT LABOR

.....Mill Date.....

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Operation	Normal Direct Man Hrs.	%	Actual Direct Man Hrs.	%	% of Normal	Superintendence	Foremen	Mill Office	Total 7-9	% Unused Charge to Unabsorbed	% Used Charge to Production	Indirect Labor Chargeable to Definite Operations	All Other	Total Chargeable to Production 12-14

FORM FOR DISTRIBUTION OF POWER, HEAT AND LIGHT

.....Mill Date.....

1	2	3	4	5	6	7
Operation	Normal Mch. Hrs.	Actual Mch. Hr.	Standard Power Rate	Amt. at Standard Power Rate	%	Adjustment Col. 5 to Total Charged to Mill

These forms also have folio columns for the purpose of noting from where and to what reports the figures are posted.

It has been previously stated that the tabulated sheets of operating report data from the tabulating office are used as journal entries for the posting of the labor charges to the different factory orders. These tabulated journal entries, as they may be called, are arranged by order numbers. The charges for each order are subdivided into man hours, machine hours, and direct labor for each operation, and are posted to the ledger sheets. On the ledger sheets the burden is extended at the respective rate of each operation. The cable mill work in process ledger contains controlling accounts for the total direct labor, burdens, pre-department charges, materials (weight and value), metals (weight), and man-hours charged to the cable mill.

Cost of Sales Statement

At the end of each month a journal voucher in the form of a cost of sales statement is prepared. It shows the following data concerning each shipment made during the month: Customer's name, factory order number, description (size and kind), quantity shipped, pre-department fabrication value, material value, copper (weight and value), lead (weight and value), direct labor, shop

burden, general burden, fixed charges, and administration and selling expenses, total cost, sales revenue and profit and loss.

This information is arranged with suitable sub-totals and the figures are stated in total as well as in cost per foot or per pound of finished cable. The actual costs can thereby be compared with the cost estimates.

Abnormal or Re-working Charges

Orders for power cables are accompanied by definite specifications. Cable is subject to rigid inspection and testing before it is shipped. Occasionally cables do not pass these tests, due to a number of reasons, such as imperfect insulation, failure on bending test, etc. It becomes necessary in such cases to strip the cable of its lead sheath, repair or re-work it and re-lead it. At this point the problem arises as to whether or not the cost of reworking such cables should be charged to those particular cables or whether the cost should be distributed over all orders. The solution must be based on the general class of business. Cables that do not pass the necessary tests are not confined to any particular class, size or kind of cable. For example, on one order of cable consisting of eight reels (one length of cable on a reel), which is all manufactured at the same time, seven reels may pass 100% perfect, but one of the reels, let us say, does not pass the test. Unless an order calls for extreme requirements, therefore, the labor required to re-work the cable is charged as a shop burden item to be spread over all lead covered cables made. When an inquiry is received by the sales department for a quotation on a class of product which requires extreme care in its manufacture, allowances are made for this fact in quoting a price. If this business should then be secured, any re-working cost sustained is charged to the order. On all other orders, however, the cost of all stripping, re-working and re-leading is charged in memorandum form on the ledger sheets of those factory orders on which work is done. Close watch should be kept on all orders to see whether any particular class or classes of product are requiring excessive re-working charges.

Statistics for Pre-Determining Costs

At the completion of a month's business the tabulating office prepares from the same cards used for tabulating the journal entries a tabulation which shows the production on each order by machines. On this tabulation there is also entered a description of the product called for by the order. This information is entered in the form of key numbers, and from it a set of master cards to be used for the tabulation of statistical and production data are punched. For statistical purposes, a tabulation is made from the master cards which shows the production of each kind of product on every operation, together with the corresponding man-hours and

machine-hours. For production control the tabulation is made for each machine. The information contained in these tabulations is posted to record sheets called recapitulation of machine production (see page 13). By means of the monthly entries thus made several rates are calculated on each sheet, namely the current machine hour rate per foot or per pound, the average to date rate, and an average for the three months immediately preceding. All of these rates are in man-hours and machine-hours per unit of production. The rates so determined are then shown graphically in the form of curves, one graph for each operation or machine. On one side of the sheet showing these graphs is a scale covering the range of possible production on the operation concerned. For instance, in the leading operation, which consists of placing a sheath of lead around the finished cable (the thickness of this sheath varying with the specifications), the kind of production is indicated in terms of the cross sectional area of the sheath. On the other side of the graph there is a scale indicating the man-hours and machine-hours per pound or per foot.

As requests for cost estimates on inquiries are received from the sales department, these graphs are used in conjunction with reports from the payroll section showing the average hourly earnings on the various operations. A specially ruled form is used for these cost estimates, one for each estimate. The form provides for a complete analysis of the constituents of the cable by materials, and operations by man-hours and machine-hours. The former are taken from material statistics and the latter from the graphs mentioned. The material costs are extended at the various material prices and the labor at the current average hourly earnings of direct labor on the different operations. It should be noted that the number of men assigned to one machine may vary depending on the class of production. The burden is also extended at the different rates. These rates are subject to careful consideration. The burden rates under abnormal conditions are not considered. Only the burden rates of normal operating times are used, and these are adjusted to any serious changes in the prices of those items which comprise the burden costs.

On a form similar to the above the actual costs of each order as it passes through the mill are accumulated. Comparisons can thereby be made between the cost estimates and the actual costs.

Production Control Data

For gathering data for production control, use is made of the master tabulating cards referred to in the description of the detail affecting the statistics for pre-determining costs. A tabulation of these cards is made, which shows the production of each machine and machine group, and the corresponding man-hours and machine hours. In conjunction with these tabulations a monthly statement

of total shipments of bare and insulated cable is issued. A sample form of this statement is shown below.

RECAPITULATION OF MACHINE PRODUCTION

Cable Mill ..... Size..... Machine No.....

Period	Ft. or Lbs.	Mch. Hours	Ft. or Lbs. per Inch. Hr.	Man Hours	Ft. or Lbs. per Man Hr.
Jan., 1921, Current					
To Date					
3 Months					
Feb., 1921, Current					

	1920			1921		
	March	April	Total to Date	March	April	Total to Date
Covered cable—feet shipped						
Covered cable—man hours—actual						
Covered cable—man hours—standard						
Covered cable—man hours—efficiency ...						
Covered cable—machine hours—actual ...						
Covered cable—machine hours—standard .						
Covered cable—machine hours—efficiency .						
Bare cable—pounds shipped						
Bare cable—man hours—actual						
Bare cable—man hours—standard						
Bare cable—man hours—efficiency						
Bare cable—machine hours—actual						
Bare cable—machine hours—standard ...						
Bare cable—machine hours—efficiency ...						
Total cable—man hours—actual						
Total cable—man hours—standard						
Total cable—man hours—efficiency						
Total cable—machine hours—actual						
Total hours—machine hours—standard ..						
Total cable—machine hours—efficiency ..						

General Remarks

Precautions should be taken to see that all reports are correctly handled at the source. Any laxity allowed at this point will undoubtedly cause inaccurate results. Regardless of who makes out the original records, this part of the work should be checked up regularly. Care should be taken to see that the original records are being made with reasonable correctness. In some parts of the mill it has been found that the preparation of original records can safely be left to the operators at the machines. Usually, when the operators are of average intelligence and the nature of the reports and reasons for them have been intelligently explained, a very decided interest and pride is taken in making out the reports. In this matter everything depends on the common sense and vision

of the individual who attempts to secure this information for the cost department. It will be well for him to keep in mind the words of Robert Louis Stevenson, "The greatest engineering achievement is the scientific management of men."

The data that is being collected should be subject to constant scrutiny. As time goes on and the results from any of it indicate that on any operation, or on any class of orders, or on material consumption, the rates derived are becoming practically uniform, the work and expense of collecting such information should, unless some good reason to the contrary exist, be eliminated.

Cost of Securing Cost Information

The question frequently arises as to how much it really costs to secure cost information. The expense on a twelve months' basis of securing the data as outlined is as follows. Three employees devote their time exclusively on cable mill accounting and estimating work. In addition aproximately half the time of one of the comptometer operators and twenty per cent of the tabulating section's time is taken up with the work. The tabulating section consists of one operator and two assistants. The tabulating equipment consists of one tabulator, one sorter and two punches. It should be stated that the tabulating section handles in addition to the cable mill work, the tabulating work of all other departments, including the complete tabulation of the plant orders of the maintenance department. In the cable mill cost accounting expense, stationery supplies, and supervision are included. Of the total cable mill expense exclusive of metal and material values, the accounting expense is one and four-tenths per cent of the total. Including the metal and material values, or in other words, taking the total cost of the cables manufactured, the cost accounting expense amounts to four-tenths of one per cent.

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No. 2—Constitution and By-Laws (replaced by Vol. II, No. 1)

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